Saskatchewan
Environment and
Public Safety

Air and Land
Protection
Branch

A Guide to Laboratory Safety and Chemical Management in School Science Study Activities

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Disclaimer

The information contained in this guide has been compiled from sources believed to be reliable, accurate and representative of the best opinion on the subjects. While every reasonable effort has been made to provide dependable information Saskatchewan Environment and Public Safety and the authors cannot assume responsibility for the validity or completeness of all chemical information given or for the consequences of their use.

SUMMARY

The purpose of this guide is to provide factual information and practical guidance to the principles of laboratory safety and chemical management applicable to school science studies. The ultimate objective of the endeavour is to foster an increased awareness of personal safety and environmental protection in all aspects of school science study in Saskatchewan.

In 1986, Saskatchewan Environment and Public Safety initiated the Institutional Chemical Collection Program (ICCP) as a service to alleviate the problem of a backlog of stored hazardous, deteriorated or outdated chemicals at schools and hospitals across the province. This guide is provided as a means to prevent the re-development of the situation the ICCP sought to solve. It is also the product of a common desire expressed by managers and science instructors for documented information pertaining to safety procedures and chemical management in school laboratories.

The guide provides practical information concerning laboratory safety and emergency procedures by addressing good habits for chemical related work, facility and equipment requirements, fire or body contact contingencies and contending with chemical spills.

Chemical management methods and principles described herein include procurement, inventory, cost reduction, curriculum review, storage by compatibility and disposal. An extensive table outlining chemical specific hazard, disposal, spill clean-up and storage designations and procedures is provided for those interested in more detailed information.

1. Introduction

The ultimate objective of this discussion paper is to foster an increased awareness of personal safety and environmental protection in all aspects of school science programs within Saskatchewan. The specific purpose is to provide science teachers or lab managers with factual information and practical guidance to laboratory safety and chemical management in school science studies.

This document will address various chemical safety related aspects of science curriculums and laboratory management including hazard identification, risk reduction through curriculum substitutions, procurement, inventory, emergency procedures, compatibility, storage and disposal.

2. Background and Rationale

In 1986 Saskatchewan Environment and Public Safety initiated the Institutional Chemical Collection Program (ICCP) as a service to alleviate the problem of a backlog of stored hazardous, deteriorated or outdated chemicals at schools and hospitals across the province.

It was recognized from the outset of the program that the removal of chemicals from schools and hospitals would only be a temporary solution and may not prevent the same situation from developing in the future. Interactions with the responsible teachers and laboratory managers during chemical collection calls at the institutions revealed that information concerning laboratory safety and chemical management was minimal or almost non-existent at many locations. Most of them expressed a common desire for documented information.

Relevant information from several chemical management and laboratory safety publications or reference books have been incorporated in this introductory guide to laboratory safety and chemical management in school science programs.

Furthermore, the provision of information in a comprehensive format simplifies the development and implementation of a safe science curriculum and laboratory management program.

3. Laboratory Safety

3.1 Laboratory Safety Procedures

Attention to various aspects of laboratory safety is necessary to safeguard the health of instructors and students and to minimize the potential for loss of property and environmental damages. General noteworthy points (NIOSH, 1984) pertaining to lab safety include:

WORK HABITS

- **Never** work alone in a science laboratory or storage area.
- Never eat, drink, smoke, chew gum or tobacco in a science laboratory or storage area. Do not store food or beverage in the laboratory environment.
- Never pipette by mouth.
- Wash hands before and after work in a science laboratory, and after spill cleanups.
- Restrain loose clothing (e.g. sleeves, full cut blouses, neckties, etc.), long hair and dangling jewelry.
- Tape all Dewar flasks.
- Never leave heat sources unattended (e.g. gas burners, hot plates, heating mantles, sand baths, etc.)
- Do not store reagents and/or apparatus on lab bench, and keep lab shelves organized.
- Never place reactive chemicals (in bottles, beakers/flasks, wash bottles, etc.) near the edges of a lab bench.
- Use a fume hood when working with volatile substances.
- Never lean into the fume hood.
- Do not use the fume hood as a storage area.

- Obtain and read the Material Safety Data Sheets (MSDS) for each chemical before beginning any experiment.
- Personal protection should be provided for not only the lab worker but also the lab partner working nearby.
- Do not mix chemicals in the sink drain.
- Always inform co-workers of plans to carry out demonstrations or experiments.
- Maintain a laboratory log-book and ensure all personnel enter a full description of their activities.
- Conduct regular in-house safety and health inspections with an emphasis on improvement rather than guilt.
- Never open a reagent package until the label has been read and completely understood.

SAFETY WEAR

- ANSI (or equivalent standard) approved eye or face protection should be worn continuously.
- Gloves should be worn which will resist penetration by the chemical being handled and which have been checked for pin holes, tears, or rips.
- Wear a laboratory coat or apron to protect skin and clothing from chemicals.
- Footwear should cover feet completely; no open-toe shoes.

FACILITIES AND EQUIPMENT

- Have separate containers for trash and broken glass.
- Regularly check fume hood for proper draft; also check that exhaust air from hood vent is not redrawn into room air.
- Secure all compressed gas cylinders when in use and transport them secured on a hand truck.

- Sample breathing air space for measurement of possible contaminants, and keep good records.
- All moving belts and pulleys should have safety guards.

3.2 Emergency Procedures and Equipment

Laboratory accidents are inevitable even when sound management and safety principles are followed. Complete laboratory management should include staff training and the development of emergency response contingency plans to deal with a situation such as a fire, spill, personal injury or other mishap.

The following is a summary of recommended emergency response procedures described according to situation category.

GENERAL EMERGENCY PROCEDURES

- Lab personnel should have recent training in first aid, CPR etc.
- Keep up-to-date emergency phone numbers posted next to the phone.
- Provide and monitor the condition of first aid supplies.
- Provide a communication system to the main office.
- Establish and practice the use of evacuation routes.
- Analyze new lab procedures in advance to pinpoint hazards.
- Analyze accidents to prevent repeat performances.

FIRE

- Position fire control equipment, such as portable fire extinguisher, fire blankets, sand and soda ash, near exit routes.

- Have actions pre-planned in case of a fire or other emergency (e.g. what devices should be turned off, which escape route to use, a personnel meeting place outside the building, a person designated to authorize re-entry into the building).
- Inform lab occupants about the alarm bell and what to do when it sounds.
- Carry out regular fire or emergency drills with critical reviews of the results.
- Never block any escape routes, and plan alternate escape routes.
- Never block a fire door open.
- Regularly maintain fire extinguishers and their records and train personnel in the proper use of extinguisher through mock situations.
- Regularly inspect fire blankets for rips and holes and keep good records of the inspections.

SKIN OR EYE CONTACT

- Instruct lab personnel in the proper use of eye-wash fountains or bottles, emphasizing rolling of the eyeballs and turning eyelids "inside-out".
- Ensure that eye-wash fountains or bottles will supply adequate water flow.
- Regularly inspect safety showers and eye-wash fountains and keep records of inspection.
- Obtain training and supplies for the treatment of chemical burns.

SPILLS

- Have appropriate equipment and materials available for spill control; replace when they become dated.
- Designate who will be responsible for spill clean-ups, i.e., the laboratory instructor or maintenance staff.
- Employ the proper personal protective equipment and beware of the hazards during spill cleanups.

Chemical specific spill clean-up procedures or concerns are provided in Appendix A. Detailed spill containment and cleanup procedures for several commonly used chemical categories and certain hazardous compounds are also described in Appendix A. Spill contingencies and clean-up measures are also generally found within Material Safety Data Sheets.

4. Chemical Management

The following practices and principles are suggested as a guide to sound management and handling of chemicals used for school science study programs.

4.1 Procurement, Inventory and Cost Reduction

Effective procurement of chemicals may be achieved by using the following steps as a guide prior to purchase and upon receipt of laboratory chemicals.

- If possible, buy class size quantities of chemicals or only those quantities required. Purchasing chemicals in small quantities is safer and ultimately less costly and time consuming as the need for the disposal of many overstocked chemicals can be avoided.
- Realize the hazards associated with each chemical required for an experiment. When possible use alternative chemicals that are less hazardous but illustrate the same concept.
- Known hazardous compounds that are required should be purchased in dilute form or in single-use quantities wherever possible (e.g., Concentrated acids and bases, liquid bromine, carbon tetrachloride, chloroform, sodium and potassium).
- Obtain the shelf-life of a required reagent since many hazardous wastes are time expired chemicals (e.g., ethers, benzoyl peroxide, silver nitrate, picric acid, alkali metals, perchloric acid).

- When ordering your chemicals, request from the supplier a MATERIAL SAFETY DATA SHEET (MSDS). This will inform you of any hazardous properties associated with the reagent of interest, provide compatibility data, and indicate storage and disposal requirements. Additionally, the information present on Material Safety data sheets is required at all work places where chemicals are used by the Occupational Health and General Regulations.

In regards to efficient chemical management, all laboratories should implement a chemical inventory system. Although many laboratories maintain a card inventory, these inventory lists or a copy of them should be kept outside the storage room so that, in the case of an emergency, they are readily accessible. When establishing a comprehensive chemical inventory, the following questions should be addressed:

- What and how much of each chemical is currently in stock?
- Where is each chemical currently?
- Is there overstock?
- Are any chemicals shelf-life expired?
- In the case of emergency, are any of the chemicals in storage potentially hazardous and if so, which ones and where are they?

Maintain a list of chemicals needed for the current and following years. In efforts to satisfy this control measure the following questions may be of value:

- How many chemicals were actually used the previous year?
- In what experiments were they used?
- Based on the above two criteria, how many chemicals will be required the following year?

Considerable cost savings may be achieved when purchasing by combining chemical orders with other members of a local school division. Establishing a network to share or exchange excess chemicals (recycling) may also result in reduced expenditures.

4.2 Curriculum Review - Objectives and Approach

A critical examination of the school science curriculum is a useful exercise in developing a safe program. The objective of such a review is to identify and reduce the health and environmental hazards associated with the science study program. A simplified approach to this task may be described as follows:

- Review the present curriculum and determine the chemicals and procedures employed.
- Determine the hazards associated with either the chemicals or the manner in which they are used in the study program. This will involve obtaining and considering the necessary hazard information from reference texts, Material Safety Data Sheets (MSDS) or consultations with experts.
- Determine if any less hazardous alternative chemicals or procedures may be substituted while still satisfying the objectives of the experiment or demonstration.

- Implement and periodically review the effectiveness these changes in the science studies program.

4.3 Chemical Storage by Compatibility

Many institutions presently store chemicals by sorting and placing them alphabetically according to the compound name. While this method makes the quick recovery of any substance easy, it presents a potential hazard because chemicals which may react violently or produce toxic products could be placed in close proximity. For example, copper nitrate and cyclohexane react violently while the combination of sodium cyanide and sulfuric acid or any acids will produce deadly hydrogen cyanide gas.

The solution to this particular aspect of chemical storage may be achieved by considering compatibility as the basis for the storage arrangement. The following system is suggested as a guide to the safe storage of laboratory chemicals. However, this or any guide cannot be considered infallible due to chemical age, condition, multiple component interactions or other factors.

The arrangement of compatible chemical families is initially attained by separating inorganic from organic compounds. Properties such as liquid, solids, gas, acid, base, oxidizer, reducer, air reactive, water reactive and others are then considered when chemicals are classified into compatible categories.

Once the chemicals have been categorized they should be stored on shelves or in special cabinets according to the patterns depicted in Figures 1 and 2. A comprehensive listing of chemical specific designations for this storage system is provided in Appendix A.

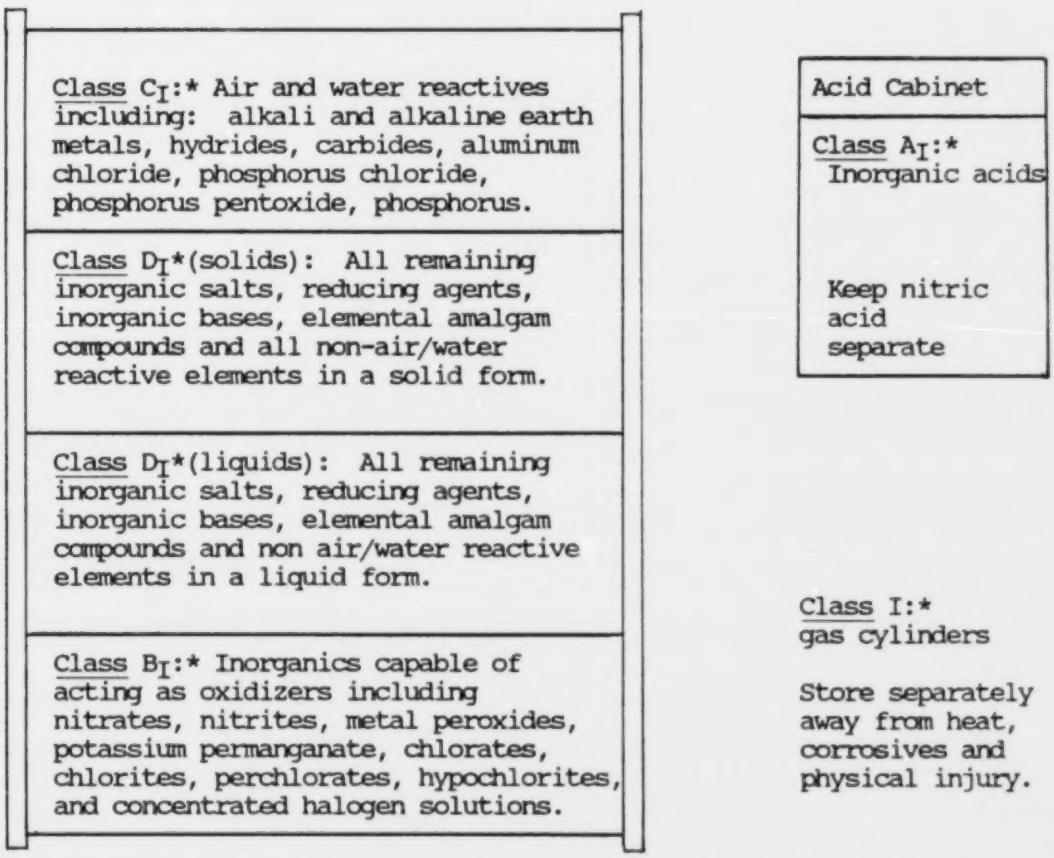
In addition to the above noted storage system the following general chemical storage practices should be adopted.

- Store chemicals in a dedicated room apart from the main laboratory. Operational access should be restricted and locked when the facility is not in use.
- Shelving assemblies should be firmly secured to the wall with anti-roll lips provided on the shelves.
- Avoid adjustable shelf supports.
- If possible, store flammable chemicals in a dedicated flammables cabinet.
- If possible, store severely poisonous chemicals in a dedicated poisons cabinet.
- If possible, store inorganic acids in a dedicated acids cabinet with nitric acid in the same cabinet only if isolated from other acids.
- Avoid temporary floor or aisle storage of chemicals.
- Avoid storing chemicals above eye level.
- Only use an explosion-proof refrigerator for lab storage.
- Never store chemicals, reagents or solutions in unlabelled containers.

- Label all chemical containers accurately with date of receipt, or preparation, initialed by the person responsible, and pertinent precautionary information on handling if it is not already present.
- Ensure that the storage room has adequate ventilation.
- Furnaces or water heaters should not be located in the chemical storage room.

Figure 1

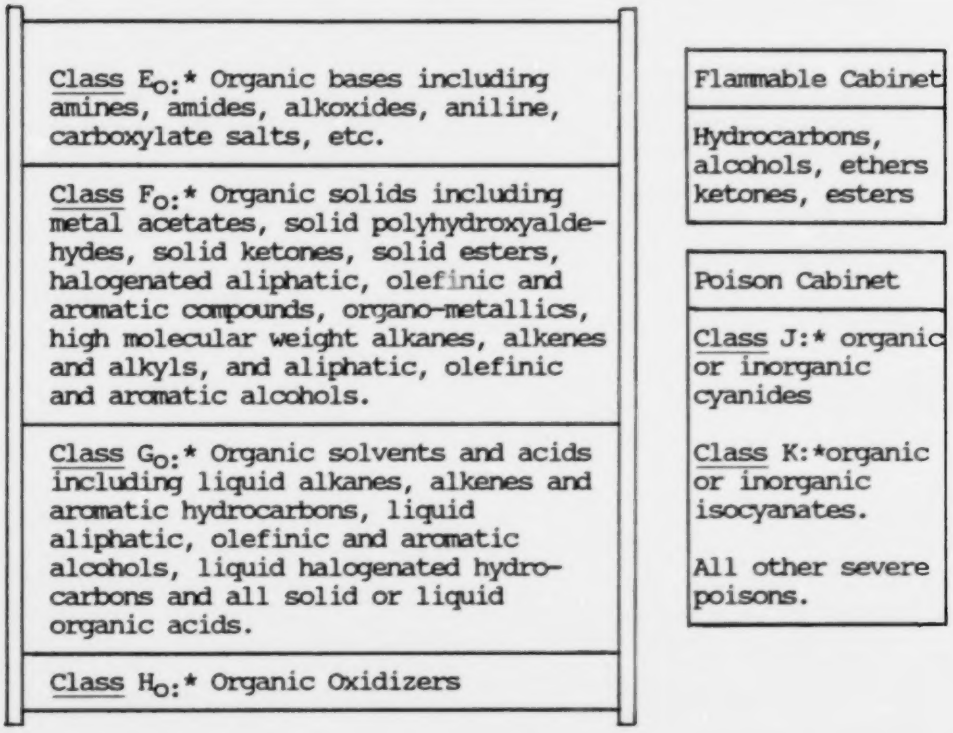
Suggested Shelf Storage Pattern for Inorganic Chemicals


Class C_I:* Air and water reactives including: alkali and alkaline earth metals, hydrides, carbides, aluminum chloride, phosphorus chloride, phosphorus pentoxide, phosphorus.
Class D_I*(solids): All remaining inorganic salts, reducing agents, inorganic bases, elemental amalgam compounds and all non-air/water reactive elements in a solid form.
Class D_I*(liquids): All remaining inorganic salts, reducing agents, inorganic bases, elemental amalgam compounds and non air/water reactive elements in a liquid form.
Class B_I:* Inorganics capable of acting as oxidizers including nitrates, nitrites, metal peroxides, potassium permanganate, chlorates, chlorites, perchlorates, hypochlorites, and concentrated halogen solutions.
Acid Cabinet
Class A_I:* Inorganic acids
Keep nitric acid separate
Class I:* gas cylinders
Store separately away from heat, corrosives and physical injury.

* Refer to pages A30 through A33 for a detailed explanation of the chemical class designations.

Figure 2

Suggested Shelf Storage Pattern for Organic Chemicals


Class E_O:* Organic bases including amines, amides, alkoxides, aniline, carboxylate salts, etc.
Class F_O:* Organic solids including metal acetates, solid polyhydroxyaldehydes, solid ketones, solid esters, halogenated aliphatic, olefinic and aromatic compounds, organo-metallics, high molecular weight alkanes, alkenes and alkyls, and aliphatic, olefinic and aromatic alcohols.
Class G_O:* Organic solvents and acids including liquid alkanes, alkenes and aromatic hydrocarbons, liquid aliphatic, olefinic and aromatic alcohols, liquid halogenated hydrocarbons and all solid or liquid organic acids.
Class H_O:* Organic Oxidizers
Flammable Cabinet
Hydrocarbons, alcohols, ethers ketones, esters
Poison Cabinet
Class J:* organic or inorganic cyanides
Class K:*organic or inorganic isocyanates.
All other severe poisons.

* Refer to pages A30 through A33 for a detailed explanation of the chemical class designations.

4.4 Chemical Disposal

In order to reduce potential environmental damages only limited disposal of unwanted non-hazardous chemicals should be undertaken by laboratory personnel. In this regard chemical specific disposal guidelines are provided in Appendix A.

While most dangerous chemicals can be rendered non-hazardous by special treatment procedures, the required facilities are generally not available at many school laboratories. In these instances the removal of hazardous chemicals by a commercial waste handling firm is often the best alternative. The following guidelines should be followed in such events:

- Prepare a complete list of chemicals of which you wish to dispose.
- Classify each of the chemicals on the disposal list into a hazardous or non-hazardous waste chemical. (Consult Appendix A)
- Unlabelled bottles (a special problem) must be identified to the extent that they can then be classified as hazardous or non-hazardous wastes.
- Contact the Department of Environment and Public Safety for further information regarding the final disposal of the hazardous chemicals.

5. Suggested Reading

The following is a listing of additional information sources and reference materials.

Committee on Hazardous Substances in the Laboratory, Assembly of Mathematical and Physical Sciences, National Research Council. 1981. Prudent Practices for Handling Chemicals in Laboratories. National Academy Press, Washington, D.C.

Committee on Hazardous Substances in the Laboratory, Commission on Physical Sciences, Mathematics and Resources, National Research Council. 1983. Prudent Practices for Disposal of Chemicals from Laboratories. National Academy Press, Washington, D.C.

Environmental Protection Service. Unpublished report. Technical manual for the Management of Chemical Wastes in Laboratories. Environment Canada, EPS, Ottawa, Ontario.

Hawley, G. The Condensed Chemical Dictionary. 10th ed. 1981. New York: Van Nostrand Reinhold Co.

Manufacturing Chemists Association, 1974. Laboratory Waste Disposal Manual, Manufacturing Chemists Assoc., 1825 Connecticut Ave., Washington, D.C.

National Health and Welfare, 1986. Guidelines on Toxic and Hazardous Chemicals Used in Educational Institutions. Saskatchewan 1986 edition. Saskatchewan Environment, Land Protection Branch, Regina, Saskatchewan.

National Institute for Occupational Health and Safety, 1984. School Science Laboratories A Guide to Some Hazardous Substances. Prepared by the Council of State Science Supervisors. U.S. Consumer Product Safety Commission, Washington, D.C.

Saskatchewan Labour. 1981. Chemical Substances Regulations A Guide to Compliance for Occupational Health Committees, Employers and Workers. Saskatchewan Labour, Occupational Health and Safety Branch, Regina, Saskatchewan.

Transport Canada. 1985. Regulations Respecting the Handling, Offering for Transport and Transporting of Dangerous Goods. Extract from the Canada Gazette Part II, February 6, 1985. (plus amendments)

7. References

Burton, H. and P. F. G. Praill. 1955. Perchloric Acid and Some Organic Perchlorates. Analyst 80.4.1955.

Chemical Rubber Company. 1976. Handbook of Laboratory Safety, 2nd Ed. Chemical Rubber Company, Cleveland, Ohio. pp. 250.

Davies, A. G., 1956. Explosion Hazards of Autoxidized Solvents. J. Royal Inst. Chem. pp 386-1956.

National Institute for Occupational Health and Safety (NIOSH), 1984. School Science Laboratories A Guide to Some Hazardous Substances. Prepared by the Council of State Science Supervisors, U.S. Consumer Product Safety Commission, Washington, D.C.

Noller, C. R., 1951. Chemistry of Organic Compounds. W. B. Saunders Co. Philadelphia.

Saskatchewan Labour. 1981. Chemical Substances Regulations. A Guide to Compliance for Occupational Health Committees, Employers and Workers. Occupational Health and Safety Branch, Regina, Saskatchewan.

Glossary

Aliphatic: Straight chain hydrocarbons.

Alkali metal: A metal in Group I A of the periodic table, i.e., lithium, sodium, potassium, rubidium, cesium, and francium. They react vigorously at times violently with water.

Alkaline-earth metal: A metal in group II A of the periodic table, i.e., magnesium, calcium, barium, strontium and radium.

Alkanes: A type of saturated Aliphatic hydrocarbon with the formula C_NH_{2N+2}.

Alkenes: A type of Olefinic hydrocarbon with one double bond.

Alkyl: A class of paraffinic hydrocarbon derived from alkanes by dropping one hydrogen from the formula. They have the formula C_NH_{2N+1} and are represented in formulas by the letter R.

Amalgram: A mixture or alloy of mercury with any of a number of metals or alloys, including calcium, sodium, tin, zinc, potassium, silver as well as with some non metals.

Amide: A nitrogenous compound which maybe either organic or inorganic. Reaction of an alkali metal with ammonia yields an inorganic amide (e.g. sodium amide $NaNH_2$). Organic amides are characterized by the functional acyl group ($-CONH_2$) which are attached to an organic group ($RCONH_2$).

Amine: A class of organic compounds of nitrogen that may be considered as derived from ammonia (NH_3) by replacing one or more of the hydrogen atoms with alkyl groups. They are all basic in nature.

ANSI: American National Standards Institute

Aromatic: Acyclic (closed ring) hydrocarbon with hexagonal structure (three double bonds).

Carbide: A binary solid compound of carbon and another element. The most familiar carbide is that of calcium CaC_2 which upon the addition of water generates acetylene gas.

Ethers: A class of organic compounds in which an oxygen atom is interposed between two carbon atoms in the molecular structure (generic formula ROR).

Ester: A organic compound with the generic structure $R\overset{O}{\overset{\|}{C}}OR$.

Ethers: A class of organic compounds in which an oxygen atom is interposed between two carbon atoms in the molecular structure (generic formula ROR).

Halogenated: A compound into which one or more halogen atoms, usually chlorine or bromine, has been incorporated.

Hydrides: An inorganic compound of hydrogen with another element. The most common hydride are sodium hydride (NaH) lithium hydride (LiH) and aluminum hydride (AlH_3). This group of compounds are known to be highly toxic, irritants, flammable, and to react violently with water and oxidizers.

Ketone: A class of organic compounds on which the carbonyl group, C=O, is attached to two alkyl groups.

MSDS: Material Safety Data Sheet

NIOSH: National Institute for Occupational Health and Safety

Oxidizing Material: Any compound that spontaneously evolves oxygen either at room temperature or under slight heating. The term includes such chemicals as peroxides, chlorates, perchlorates, nitrates and permanganates. These compounds can react vigorously at ambient temperatures when stored near or in contact with reducing materials.

Reducing Materials: Any compound that removes or accepts oxygen.

APPENDIX A

CHEMICAL SPECIFIC HAZARD, DISPOSAL, SPILL CLEANUP AND STORAGE GROUP DESIGNATIONS

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
acacia gum	1	1	1	2	21	F_O
acetaldehyde	2	4	2	13	2	G_O
acetamide	1	1	1	2	20	E_O
acetanilide	2	1	1	2	20	E_O
acetic acid (concentrated)	4	3	3	1	24a	G_O
acetic anhydride	4	3	3	8	24a	G_O
acetone	1	3	1	10	18	G_O
aceto - carmine stain	1	1	1	2	21	F_O
aceto - orcein (2% solution)	1	1	1	2	21	G_O
acetyl chloride	4	4	4	Special Hazard See Appendix B		
acetylcholine bromide	2	1	1	2	21	F_O
acridine orange	2	1	1	2	5	F_O
adipic acid	1	1	1	2	24a	G_O
adipyl chloride	2	1	2	8	4c	G_O
adrenaline	2	1	1	1	21	F_O
agar flake	1	1	1	2	21	F_O
agar powder	1	1	1	2	21	F_O
albumin	1	1	1	2	21	F_O
alizarin red	2	1	1	2	18	Fo
alizarin yellow	2	1	1	2	18	Fo
alum	1	1	1	2	11	D_I/s
alumina (aluminum oxide)	2	1	1	2	21	D_I/s
aluminum sulphate and ammonium	1	1	2	2	21	D_I/s
aluminum carbide	2	3	3	16	25	C_I
aluminum carbonate	1	1	1	2	21	D_I/s
aluminum chloride, anhydrous	2	1	2	8	1b	C_I
aluminum hydroxide	1	1	1	2	21	D_I/s
aluminum metal	1	1	1	2	27a	D_I/s
aluminum metal (dust)	2	3	3	5	21	D_I/s
aluminum nitrate	1	3	3	4	12a	B_I

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
aluminum potassium phosphate	1	1	1	2	21	$D_{I/s}$
aluminum potassium sulphate	1	1	1	2	21	$D_{I/s}$
aluminum sodium sulfate	1	1	1	2	21	$D_{I/s}$
aluminum sulfate	1	1	1	2	11	$D_{I/s}$
aluminum sulfide	2	2	2	6	23	C_I
amberlite ion exchange resins	1	1	1	2	21	Fo
ammonia (anhydrous, gas)	4	2	4	14	GC	I
ammonium acetate	1	1	1	2	21	$D_{I/s}$
ammonium alum	1	1	1	2	21	$D_{I/s}$
ammonium bicarbonate	1	1	1	2	21	$D_{I/s}$
ammonium bifluoride	3	1	3	7	10	$D_{I/s}$
ammonium bromide	2	1	2	3	1b	$D_{I/s}$
ammonium chloride	1	1	1	2	1b	$D_{I/s}$
ammonium chromate	2	2	2	3	11	$D_{I/s}$
ammonium citrate	1	1	1	2	21	B_I
ammonium dichromate	2	2	2	4	12a	B_I
ammonium ferrous sulfate	1	1	1	2	11	$D_{I/s}$
ammonium fluoride	3	1	3	7	1b	$D_{I/s}$
ammonium hydroxide (concentrated)	3	1	3	6	10	$D_{I/L}$
ammonium hydroxide (diluted 10%)	2	1	2	1	10	$D_{I/L}$
ammonium metavanadate	2	1	2	3	27i	$D_{I/s}$
ammonium molybdate	2	1	2	3	21	$D_{I/s}$
ammonium nitrate	1	4	3	4	12a	B_I (separate)
ammonium oxalate	3	1	2	13	24a	Fo
ammonium phosphate (monobasic)	1	1	1	2	21	$D_{I/s}$
ammonium phosphate (dibasic)	1	1	1	2	21	$D_{I/s}$
ammonium polysulfide solution	3	1	3	6	23	$D_{I/L}$
ammonium sulfamate	2	1	2	3	19	$D_{I/s}$
ammonium sulfate	1	1	1	2	11	$D_{I/s}$

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
ammonium sulfide	3	1	3	6	23	D_I/s
ammonium sulfite	2	1	2	6	12b	D_I/s
ammonium thiocyanate	2	1	2	2	11	J
ammonium thiosulfate	1	1	2	2	12b	D_I/s
amyl acetate	1	2	1	10	18	G_O (flammable)
amyl alcohol	2	2	1	10	18	G_O (flammable)
aniline	3	2	1	Special Hazard - See Appendix B		
aniline blue (water soluble)	3	1	1	2	5	F_O
antimonous chloride	2	1	2	8	27d	D_I/s
antimony metal	2	1	1	3	27a	D_I/s
antimony pentachloride	2	1	3	16	27d	C_I
antimony pentasulfide	2	3	2	16	27d	D_I/s
antimony potassium tartrate	2	1	1	16	27d	Fo
antimony sulfate	2	1	1	16	27d	D_I/s
antimony trioxide	2	1	1	16	27d	D_I/s
antimony trisulfide	2	1	1	16	27d	D_I/s
arsenic metal	3	1	1	16	27d	D_I/s (poison)
arsenic pentoxide	3	1	1	16	27d	D_I/s (poison)
arsenic trichloride	4	1	4	16	27d	D_I/s (poison)
aresnic trioxide	4	1	1	16	27d	D_I/s (poison) (carc.)
ascarite	2	1	1	2	21	D_I/s
ascorbic acid	1	1	1	2	21	F_O
bacto-lipase base	1	1	1	2	21	D_I/s
balsam, Canada	1	1	1	2	21	G_O
barium carbonate	2	1	2	6	27h	D_I/s
barium chloride	2	1	1	3	27h	D_I/s (poison)
barium dioxide	2	1	1	4	27h	B_I
barium hydroxide	2	1	1	6	27h	D_I/s
barium nitrate	2	1	2	4	27h	B_I
barium sulfide	2	1	2	6	27h	D_I/s
basic fuchsin (special)	1	1	1	2	21	E_O
beef extract	1	1	1	2	21	F_O
Benedict's qualitative solution	2	1	1	1	21	D_I/L
benzoic acid	1	1	1	2	24a	G_O

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
benzophenone	2	1	1	3	18	F_O
benzoyl peroxide	3	4	4	Special Hazard - See Appendix B		
bile salts	1	1	1	2	21	G_O
bismarck brown Y	2	1	1	2	5	E_O
bismuth metal	2	1	1	3	27d	D_I/s
bismuth nitrate	2	2	2	4	27d/12a	B_I
bismuth oxide	2	1	1	3	27d	D_I/s
bismuth trichloride	2	1	2	8	27d	C_I
biuret (reagent)	2	1	1	1	20	E_O
biuret (MP 177°)	2	1	1	2	20	E_O
boric acid crystal	1	1	1	2	24b	A_I
boron metal	1	1	1	16	21	C_I
Bouin's fluid	3	1	1	1	21	G_O (keep saturated with water)
bromine (reagent)	4	2	4	Special Hazard - See Appendix B		
bromine (water)	3	1	3	7	12a	B_I
bromoacetanilide	2	1	1	6	6	E_O
bromoethane (reagent)	2	1	2	11	4b	G_O (flammable)
bromothymol blue	1	1	1	1	21	G_O
broth (nutrient)	1	1	1	1	21	E_O
butanol	2	2	1	10	18	G_O
n-butyl phthalate	2	1	1	10	18	G_O
iso-butyl alcohol	2	2	1	10	18	G_O (flammable)
s-butyl alcohol	2	2	1	10	18	G_O (flammable)
t-butyl alcohol	2	2	1	10	18	G_O (flammable)
butyric acid	2	2	1	7	24a	G_O
cadmium carbonate	3	1	1	16	27f	D_I/s (poison)
cadmium iodide	3	1	1	16	27f	D_I/s (poison)
cadmium metal	3	1	1	16	27f	D_I/s (poison)
cadmium nitrate	3	2	3	16	27f	B_I
caffeine	1	1	1	2	21	F_O
calcium acetate	1	1	1	2	21	Fo
calcium carbide	3	3	3	16	25	C_I
calcium carbonate (powder)	1	1	1	2	11	D_I/s
calcium chloride	1	1	1	2	11	D_I/s
calcium fluoride	2	1	1	16	1b	D_I/s
calcium hydroxide	1	1	1	6	10	D_I/s
calcium hypochlorite	2	1	2	4	12a	B_I

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
calcium metals (turnings)	3	1	3	9	3	C_I
calcium metal	3	1	3	9	3	C_I
calcium nitrate	1	2	3	4	12a	B_I
calcium oxide	3	2	3	9	10	D_I/s
calcium phosphate (mono-basic)	1	1	1	2	21	D_I/s
calcium phosphate (tri-basic)	1	1	1	2	21	D_I/s
calcium propionate	1	1	1	2	21	D_I/s
calcium sulfate	1	1	1	2	21	D_I/s
calcium sulfide	2	1	2	6	23	D_I/s
camphor	2	1	1	2	18	G_O (flammable)
carbon	1	1	1	2	21	D_I/s
carbon disulfide	2	3	1	Special Hazard - See Appendix B		
carbon tetrachloride	2	1	1	Special Hazard - See Appendix B		
carborundum powder	1	1	1	2	21	D_I/s
carmine (biological stain)	2	1	1	2	21	G_O
casein pure	1	1	1	2	21	F_O
cerous sulfate	1	1	1	2	21	D_I/s
cesium chloride	1	1	1	2	21	D_I/s
charcoal	1	1	1	2	21	Fo
chlorine water (saturated)	2	1	2	7	12a	B_I
2-chloro-2-methylpropane	3	3	1	11	4b	G_O (flammable)
chromium acetate	2	1	1	16	27f	Fo
chromium chloride	2	1	1	16	27f	D_I/s
chromium metal	1	1	1	16	27f	D_I/s
chromium nitrate	2	2	2	4	27f	B_I
chromium potassium sulfate	2	1	1	16	27f	D_I/s
chromium trioxide	3	1	3	4	27f	B_I (poison)
citric acid	1	1	1	1	21	G_O
cobalt (wire)	1	1	1	2	27a	D_I/s
cobalt carbonate	2	1	1	2	11	D_I/s
cobalt chloride (paper)	2	1	1	2	11	D_I/s
cobaltous chloride	2	1	1	2	11	D_I/s
cobaltous nitrate	2	2	3	4	12a	B_I
cobaltous sulfate	2	1	1	2	11	D_I/s

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
coconut oil	1	1	1	2	21	G_O
collodion	2	4	1	10	28	G_O (flammable)
congo red	1	1	1	2	21	E_O
copper metal	1	1	1	2	27a	D_I/s
corn starch	1	1	1	2	21	F_O
cottonseed oil	1	1	1	2	21	G_O
crystal violet (staining solution)	1	1	1	1	5	G_O
cupric acetate	2	1	1	3	21	Fo
cupric bromide	2	1	1	3	11	D_I/s
cupric carbonate	2	1	1	3	11	D_I/s
cupric chloride	2	1	1	3	11	D_I/s
cupric nitrate	2	2	3	4	12a	B_I
cupric oxide	2	1	1	3	11	D_I/s
cupric sulfate	2	1	1	3	11	D_I/s
cupric sulfide	2	1	1	6	23	D_I/s
cuprous chloride	2	1	1	3	11	D_I/s
cyclohexanol	2	2	1	10	18	G_O
cyclohexane	2	2	1	10	18	G_O (flammable)
devarda's alloy	1	1	1	9	21	D_I/s
dextrose	1	1	1	2	21	F_O
diastase	1	1	1	2	21	F_O
dibromobenzene (para)	2	1	1	16	4b	G_O
dichlorobenzene (para)	2	1	1	16	4b	G_O
dichloromethane	2	1	1	11	4b	G_O
dichlorotetrafluoroethane	1	1	1	14	GC	I (gas cylinder)
diethyl ether	2	4	4	Special Hazard - See Appendix B		
4,5-dihydroxy-3-(p-sulfophenyl-azo)-2,7 napthalene disulfonic acid trisodium salt	2	1	1	3	8	F_O
dimethyl glyoxime	2	1	2	3	21	F_O
dinitrophenylhydrazine	2	4	4	Special Hazard - See Appendix B		
diphenylamine	3	1	2	12	5	E_O
s-diphenyl carbizone	2	1	2	3	8	G_O
eosin B	2	1	1	2	4b	F_O
eosin Y (ph 0.0-3.0)	2	1	1	2	4b	F_O

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
eriochrome black	2	1	1	2	21	F_O
ethyl acetate	2	4	1	10	18	G_O (flammable)
ethyl alcohol	1	2	1	10	18	G_O (flammable)
ethylamine	3	3	3	12	7	E_O (flammable)
ethyl bromide	2	1	1	11	4b	G_O (flammable)
ethyl butyrate	2	2	1	10	18	G_O (flammable)
ethyl carbamate	2	1	1	3	18	E_O
ethylenediamine	3	3	2	12	7	E_O
ethylene dichloride	2	3	1	11	4b	G_O (flammable)
ethylene glycol (reagent)	2	1	1	2	18	G_O
ethylenedinitrilo-tetraacetic acid (EDTA)	2	1	1	2	21	G_O
ethyl ether (diethyl ether)	3	4	2	Special Hazard - See Appendix B		
ethyl iodide	2	2	1	11	4b	G_O
Fehling alkaline No. 1	2	1	1	1	21	$D_{I/L}$
Fehling alkaline No. 2	2	1	1	1	21	$D_{I/L}$
ferric ammonium citrate	1	1	2	2	21	Fo
ferric ammonium sulfate	2	1	1	2	11	$D_{I/s}$
ferric chloride	2	1	1	2	11	$D_{I/s}$
ferric nitrate	2	2	2	4	12a	B_I
ferric oxide	1	1	1	2	21	$D_{I/s}$
ferric sulfate	1	1	1	2	21	$D_{I/s}$
ferrous ammonium chloride	1	1	1	2	11	$D_{I/s}$
ferrous ammonium sulfate	1	1	1	2	11	$D_{I/s}$
ferrous ammonium sulfite	1	1	1	8	12b	$D_{I/s}$
ferrous chloride	2	1	1	2	11	$D_{I/s}$
ferrous sulfate	2	1	1	2	11	$D_{I/s}$
ferrous sulfide	1	1	2	2	23	$D_{I/s}$
ferrous sulfite	2	1	2	8	12b	$D_{I/s}$
fluorescein (free acid)	2	1	1	2	21	F_O
formalin (conc.)	3	1	3	13	2	G_O (flammable)
formic acid	2	2	2	1	24a	G_O
fructose	1	1	1	2	21	F_O
fuchsin (acid)	2	1	1	2	21	G_O
fumaric acid	1	1	1	2	24a	G_O

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
gelatin	1	1	1	2	21	F_O
geraniol	1	1	1	2	18	G_O
gibberellic acid	1	1	1	2	24a	G_O
glycerin jelly	1	1	1	2	24a	G_O
glycerol	1	1	1	2	18	G_O
gold chloride	2	1	1	2	return for salvage	D_I/s
graphite (powder)	1	1	1	2	21	D_I/s
heptane	2	4	1	10	18	G_O (flammable)
hexane	2	4	1	10	18	G_O (flammable)
1,6-hexanediamine	2	2	2	12	7	E_O
hydriodic acid	2	1	3	7	24b	A_I (acid)
hydrobromic acid	2	1	3	14	24b	A_I (acid)
hydrochloric acid (4%)	2	1	2	1	24b	A_I (acid)
hydrochloric acid (4% - - 24%) (N - 6N)	3	1	3	7	24b	A_I (acid)
hydrofluoric acid	4	1	4	Special Hazard - See Appendix B		
hydrogen peroxide 3%	1	1	1	1	22a	B_I
hydrogen peroxide 30%	4	1	4	16	22a	B_I
hydrogen sulfide	3	3	2	14	GC	I (gas cylinder)
hydroquinone	2	1	2	13	18	G_O
indigo carmine	2	1	1	2	4c	F_O
3-indoleacetic acid	1	1	2	2	4c	G_O
iodine	2	1	2	4	12a	B_I
iodine solution (1N)	2	1	1	1	12a	D_I/L
ion exchange resins	1	1	1	2	21	F_O
iron metal	1	1	1	2	21	D_I/s
iron pyrites	1	1	2	2	21	D_I/s
iron sulfide	1	1	2	2	23	D_I/s
isobutyl alcohol	2	2	1	10	18	G_O (flammable)
isopropyl alcohol	2	2	1	10	18	G_O (flammable)
kaolin	1	1	1	2	21	D_I/s
kerosene	2	2	1	10	18	G_O
lactic acid	1	1	1	2	24a	G_O
lactose	1	1	1	2	21	F_O
lanolin (anhydrous)	1	1	1	2	21	F_O
lanthanum nitrate	3	2	3	4	12a	B_I

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
lauric acid	1	1	1	2	24a	G_O
lauroyl peroxide	3	3	3	Special Hazard - See Appendix B		
lead arsenate	2	1	1	16	27d	$D_{I/s}$ (poison)
lead carbonate	2	1	1	16	27f	$D_{I/s}$ (poison)
lead chloride	2	1	1	16	27f	$D_{I/s}$ (poison)
lead chromate	2	1	1	16	27f	$D_{I/s}$ (poison)
lead dioxide	2	1	1	16	27f/12a	B_I
lead metal	2	1	1	16	27a	$D_{I/s}$
lead nitrate	2	2	3	16	27f/12a	B_I (poison)
lead oxide (red)	2	1	1	16	27f	$D_{I/s}$ (poison)
lead oxide (yellow)	2	1	1	16	27f	$D_{I/s}$ (poison)
lead sulfide	2	1	1	16	27f	$D_{I/s}$ (poison)
limewater (tablets)	1	1	1	2	21	$D_{I/s}$
lithium acetate	2	1	1	2	11	F_O
lithium aluminum hydride	3	1	3	Special Hazard - See Appendix B		
lithium chloride	2	1	1	2	11	$D_{I/s}$
lithium fluoride	3	1	1	3	1b	$D_{I/s}$
lithium hydroxide	4	1	3	6	10	$D_{I/s}$
lithium nitrate	2	2	2	4	12a	B_I
litmus granular blue	1	1	1	2	21	F_O
Lugol's iodine	2	1	1	1	21	$D_{I/L}$
lycopodium powder inert	1	1	1	2	21	F_O
magnesia mixture	1	1	1	2	21	$D_{I/s}$
magnesium bromide	2	1	1	2	11	$D_{I/s}$
magnesium carbonate	1	1	1	2	21	$D_{I/s}$
magnesium chloride	1	1	1	2	11	$D_{I/s}$
magnesium hydroxide	1	1	1	2	21	$D_{I/s}$
magnesium hypophosphite	2	1	2	5	11	$D_{I/s}$
magnesium metal (purified powder)	1	3	3	9	3	C_I
magnesium metal (purified ribbon)	1	2	2	9	3	C_I
magnesium rods	1	2	2	9	27a	$D_{I/s}$
magnesium sulphate	1	1	1	2	21	$D_{I/s}$
malachite green	1	1	1	2	6	F_O
maleic acid	2	1	1	2	21	G_O
maleic anhydride	2	1	2	2	21	F_O

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
maltose	1	1	1	2	21	F_O
manganese carbonate	2	1	1	2	11	$D_{I/s}$
manganese dioxide	2	2	2	4	12a	B_I
manganese metal (dust)	2	2	1	9	27a	$D_{I/s}$
manganese sulfate	1	1	1	2	11	$D_{I/s}$
mannose (dl)	1	1	1	2	21	F_O
marble chips	1	1	1	2	21	$D_{I/s}$
menthol	2	1	1	2	18	F_O
mercuric chloride	3	1	1	16	27b	$D_{I/s}$ (poison)
mercuric iodide	3	1	1	16	27b	$D_{I/s}$ (poison)
mercuric nitrate	3	3	3	16	27b/12a	B_I
mercuric oxide	3	1	1	16	27b	$D_{I/s}$ (poison)
mercuric sulfate	3	1	1	16	27b	$D_{I/s}$ (poison)
mercuric sulfide	2	1	1	16	27b	$D_{I/s}$ (poison)
mercurous chloride	2	1	1	16	27b	$D_{I/s}$ (poison)
mercurous nitrate	3	3	3	16	27b	B_I (poison)
mercury chloride	3	1	1	16	27b	$D_{I/s}$ (poison)
mercury iodide	3	1	1	16	27b	$D_{I/s}$ (poison)
mercury metal	3	1	1	16	27b	$D_{I/s}$
mercury nitrate	3	1	1	16	27b/12a	B_I (poison)
mercury oxide	3	1	1	16	27b	$D_{I/s}$ (poison)
methanol	3	3	1	10	18	G_O (flammable)
2-methyl amino phenol sulfate	3	1	1	2	5	F_O
methyl cellulose	1	1	1	2	21	F_O
methyl ethyl ketone	2	2	1	10	18	G_O (flammable)
methyl methacrylate	2	2	2	10	18	G_O (flammable)
methyl orange	2	1	1	2	21	F_O
methyl p-hydroxybenzoate	2	1	1	2	18	G_O
2-methyl propanol	2	2	1	10	18	G_O (flammable)
methyl red	2	1	1	2	21	G_O
methyl red hydrochloride	2	1	1	2	21	G_O
methyl salicylate	3	1	1	10	18	G_O
methyl violet B-2	2	1	1	2	5	F_O
monochlorodifluoromethane	1	1	1	11	GC	I (gas cylinder)
napthalene (tech)	2	1	1	2	18	F_O
nickel metal (shot)	2	1	1	2	27a	$D_{I/s}$

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
nickelous acetate	2	1	1	3	11	F_O
nickelous ammonium sulfate	2	1	1	3	11	D_I/s
nickelous carbonate	2	1	1	6	11	D_I/s
nickelous chloride	2	1	1	3	11	D_I/s
nickelous nitrate	2	2	3	4	12a	B_I
nickelous sulfate	2	1	1	3	11	D_I/s
nigrosine (water soluble)	2	1	1	1	11	F_O
ninhydrin (TLC reagent)	2	1	1	2	18	G_O
nitric acid (concentrated)	4	3	4	7	24b	A_I (acid-sep.)
nitric adic (dilutes; less than 1%)	3	1	2	1	24b	A_I (acid)
nitrophenylazoresorcinol	3	1	1	3	8	F_O
octyl acetate	2	1	1	2	18	F_O
oleic acid	1	1	1	2	24a	G_O
olive oil	1	1	1	2	18	G_O
orange IV	2	1	1	2	21	F_O
oxalic acid	3	1	1	16	24a	G_O
palmitic acid	1	1	1	2	21	G_O
palm oil	1	1	1	2	21	G_O
pancreatin (powder)	1	1	1	2	21	F_O
paraformaldehyde	2	3	2	3	2	G_O
paraffin	1	2	1	2	18	F_O
pentane (normal)	2	4	1	10	18	G_O (flammable)
pentyl alcohol	2	3	1	10	18	G_O (flammable)
pepsin	1	1	1	2	21	F_O
peptone	1	1	1	2	21	F_O
perchloric acid	4	4	4	Special Hazard - See Appendix B		
permutit	2	1	1	2	21	F_O
petroleum ether	2	4	1	10	18	G_O (flammable)
petroleum jelly	1	1	1	2	21	F_O
petrolatum	1	1	1	2	21	F_O
phenolindophenol	2	1	1	3	18	G_O
phenolphthalein	2	1	1	2	21	F_O
phenol	4	2	2	3	18	G_O
phenyl benzoate	3	1	1	2	18	G_O
phenylhydrazine hydrochloride	2	2	3	5	16	F_O

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
phenylthiocarbamide	2	1	1	16	14	J
phenyl salicylate	2	1	1	2	18	F_O
1-phenyl-2-thiourea (MP 153-155°)	2	1	1	16	14	J
phosphoric acid (concentrated)	3	3	4	7	24b	A_I (acid cabinet)
phosphorous amporphous (red)	2	1	1	16	27c	C_I
phosphorous (purified, yellow)	4	4	4	Special Hazard - See Appendix B		
phosphorous pentoxide	4	4	4	Special Hazard - See Appendix B		
phosphorus trichloride	3	1	2	Special Hazard - See Appendix B		
phthalic acid	2	1	1	2	24a	G_O
phthalic anhydride	2	1	1	8	24a	G_O
picric acid	2	3	4	Special Hazard - See Appendix B		
potassium acetate	1	1	1	2	21	F_O
potassium bicarbonate	1	1	1	2	21	D_I/s
potassium bichromate	2	2	2	4	12a	B_I
potassium bisulfate	2	1	2	7	21	D_I/s
potassium bisulfite	2	1	2	7	11	D_I/s
potassium bitartrate	1	1	1	2	21	F_O
potassium binoxalate	2	1	1	2	18	F_O
potassium bromate	2	2	2	4	12a	B_I
potassium bromide	2	1	1	2	1b	D_I/s
potassium carbonate	1	1	1	6	11	D_I/s
potassium chlorate	2	4	4	16	12a	B_I
potassium chloride	1	1	1	2	21	D_I/s
potassium chromate	2	4	4	4	11	D_I/s
potassium dichromate	2	2	2	4	12a	B_I
potassium dihydrogen orthophosphate	1	1	1	2	21	D_I/s
potassium ferricyanide	2	1	1	2	11	J
potassium hydrogen carbonate	1	1	1	2	21	D_I/s
potassium hydrogen phthalate	1	2	1	2	21	F_O
potassium hydride	2	1	1	16	17	C_I
potassium tartrate	1	1	1	2	21	F_O

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
potassium hydroxide (concentrated)	4	1	4	16	10	D_I/s
potassium iodate	2	2	2	4	12a	B_I
potassium iodide	2	1	1	2	1b	D_I/s
potassium metal	4	4	4	Special Hazard - See Appendix B		
potassium nitrate	1	2	3	4	12a	B_I
potassium nitrite	2	2	2	4	12a	B_I
potassium oxalate	3	1	2	2	18	F_o
potassium perchlorate	3	3	4	16	12a	B_I
potassium periodate	3	3	3	4	12a	B_I
potassium permanganate	2	3	3	4	12a	B_I
potassium phosphate (monbasic)	1	1	1	2	21	D_I/s
potassium phosphate (tribasic)	1	1	1	2	21	D_I/s
potassium sodium tartrate	1	1	1	2	21	F_o
potassium sulfate	1	1	1	2	21	D_I/s
potassium sulfide	2	1	2	16	23	D_I/s
potassium sulfite	2	1	2	6	12b	D_I/s
potassium thiocyanate	2	1	2	2	14	J
potato dextrose agar	1	1	1	2	21	F_o
propanol	2	3	1	10	18	G_o (flammable)
propionic acid	2	2	1	7	24a	G_o
n-propyl alcohol	2	3	1	10	18	G_o (flammable)
propylene glycol	1	1	1	2	18	G_o
pyridine	2	3	2	12	5	E_o
pyrogallol	2	1	1	3	18	F_o
quinine sulfate	2	1	1	2	5	F_o
resorcinol	2	1	1	3	18	F_o
Ringer's solution	1	1	1	1	21	D_I/L
Rose's alloy	1	1	1	3	21	D_I/s
rose bengal (biological stain)	2	1	1	2	6	F_o
rose water	1	1	1	1	21	D_I/L
rosin	1	1	1	2	21	G_o
safranin - O (reddish)	2	1	1	2	21	F_o
salicylic acid	2	1	1	10	24a	G_o

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
saline solution	1	1	1	1	21	$D_{I/L}$
sand	1	1	1	2	21	$D_{I/s}$
Schiff's aldehyde	2	1	1	2	2	G_o
sebacyl chloride	1	1	1	2	1a	G_o
silica gel	1	1	1	2	21	$D_{I/s}$
silicic acid	1	1	1	2	21	$D_{I/s}$
silicon dioxide	1	1	1	2	21	$D_{I/s}$
silicon metal	1	1	1	2	21	$D_{I/s}$
silver acetate	2	1	1	4	12a	H_o (poison)
silver nitrate	2	2	3	4	12a	B_I
silver oxide	2	1	1	4	12a	B_I
silver sulfate	2	1	1	2	11	$D_{I/s}$ (poison)
soap, castile (powder)	1	1	1	2	21	$D_{I/s}$
soap solution (wanklyns')	2	1	1	2	21	$D_{I/s}$
soda lime	4	1	2	6	10	$D_{I/s}$
sodium acetate	1	1	1	2	21	F_o
sodium alkylaryl sulphonate	2	1	1	2	21	G_o
sodium arsenite	2	1	1	16	27d	$D_{I/s}$ (poison)
sodium bicarbonate	1	1	1	2	11	$D_{I/s}$
sodium binoxalate	3	1	1	2	18	Fo
sodium bismuthate	2	1	1	2	11	$D_{I/s}$
sodium bisulfite	2	1	2	6	12b	$D_{I/s}$
sodium borate	2	1	1	2	21	$D_{I/s}$
sodium bromate	2	3	3	4	12a	B_I
sodium carbonate	2	1	2	6	11	$D_{I/s}$
sodium chlorate	3	3	3	16	12a	B_I
sodium chloride	1	1	1	2	11	$D_{I/s}$
sodium chromate	2	2	2	4	11	$D_{I/s}$
sodium citrate	1	1	1	2	21	$D_{I/s}$
sodium cobaltinitrite	2	1	1	4	12a	B_I
sodium formate	2	1	1	5	12b	F_o
sodium hydrogen sulfate	2	1	2	2	11	$D_{I/s}$
sodium hydroxide (concentrated)	4	1	4	16	10	$D_{I/L}$-$D_{I/s}$
sodium hypochlorite	2	3	3	4	12a	B_I
sodium iodide	2	1	1	2	11	$D_{I/s}$
sodium metabisulfite	1	1	2	6	12b	$D_{I/s}$

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
sodium metal	3	4	4	Special Hazard - See Appendix B		
sodium metasilicate	4	1	2	16	11	$D_{I/s}$
sodium nitrate	1	2	3	4	12a	B_I
sodium oleate	1	1	1	2	21	F_o
sodium orthophosphate	1	1	1	2	21	$D_{I/s}$
sodium peroxide	3	3	3	4	22a	B_I
sodium phosphate (mono)	1	1	1	2	21	$D_{I/s}$
sodium phosphate (dibasic)	1	1	1	2	21	$D_{I/s}$
sodium phosphate (tribasic)	2	1	1	2	21	$D_{I/s}$
sodium proprionate	1	1	1	2	21	F_o
sodium pryophosphate	1	1	1	3	11	$D_{I/s}$
sodium silicate	1	1	1	1	11	$D_{I/s}$
sodium sulfate	1	1	1	2	21	$D_{I/s}$
sodium sulfide	2	1	2	6	23	$D_{I/s}$
sodium sulfite	2	1	2	6	12b	$D_{I/s}$
sodium tartrate	1	1	1	2	21	F_o
sodium thiosulfate	1	1	1	2	12b	$D_{I/s}$
stannic chloride	2	1	1	8	1b	$D_{I/s}$
stannic oxide	2	1	1	2	21	$D_{I/s}$
stannic sulfate	2	1	1	2	11	$D_{I/s}$
stannous chloride	2	1	1	2	12b	$D_{I/s}$
stannous oxide	2	1	1	2	12b	$D_{I/s}$
stannous sulphate	2	1	1	2	11	$D_{I/s}$
starch (arrow root substance)	1	1	1	2	21	F_o
starch corn	1	1	1	2	21	F_o
starch, potato	1	1	1	2	21	F_o
stearic acid	1	1	1	2	21	G_o
streptomycin sulfate	2	1	1	2	21	F_o
strontium chloride	1	1	1	2	27h	$D_{I/s}$
strontium nitrate	1	2	3	4	27h	B_I
succinic acid	1	1	1	2	21	G_o
sucrose	1	1	1	2	21	F_o
sudan III	2	1	1	2	21	F_o
sudan IV	2	1	1	2	21	F_o
sulfamic acid	2	1	1	2	19	A_I
sulfanilic acid	2	1	1	2	24a	G_o
sulfur (lumps)	1	1	1	2	21	$D_{I/s}$

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
sulfur (sublimed flowers)	1	1	1	2	21	D_I/s
sulfuric acid (concentrated)	4	1	4	16	24b	A_I (acid cabinet)
talcum (lab powder)	1	1	1	2	21	D_I/s
tannic acid	2	1	1	2	24a	G_O
tartaric acid	1	1	1	2	24a	G_O
thioacetamide	2	1	2	3	13	E_O
thiourea	2	1	1	3	13	E_O
tin metal	1	1	1	2	27a	D_I/s
tincture green soap	1	1	1	2	21	D_I/L
titan yellow	2	1	1	2	21	F_O
titanium dioxide	1	1	1	2	21	D_I/s
titanium tetrachloride	3	1	3	8	1b	D_I/L
toluene	2	3	1	10	18	G_O (flammable)
trichlorotrifluoroethane	1	1	1	11	4b	G_O
1,1,2-trichloro-1,2,2 trifluoroethane	1	1	1	11	4b	G_O
1,1,1-trichloro-2 methyl -2-propanol	2	1	1	11	4b	G_O
trichlorotributyl alcohol	2	2	2	11	4b	G_O (flammable)
triethanolamine	1	1	1	12	7	E_O
tungsten metal	1	1	1	2	21	D_I/s
tungstic acid	2	1	1	2	21	A_I
turpentine oil (rectified)	2	2	1	10	18	G_O (flammable)
turpentine (pure gum spirits)	2	2	1	10	18	G_O
universal indicator solution	2	1	1	1	21	G_O
uracil (MP 335°)	1	1	1	2	5	E_O
urea	1	1	1	2	21	E_O
vanadium metal	1	1	1	16	27i	D_I/s
vanadium pentoxide	2	1	1	16	27i	D_I/s
wood's metal (reagent stick)	1	1	1	2	21	D_I/s
Wright's stain	2	1	1	2	21	F_O
xylene	2	2	1	10	18	G_O (flammable)
yeast	1	1	1	2	21	F_O
zeolite	1	1	1	2	21	D_I/s

Chemical	Toxicity and/or Corrosivity	Flammability	Explosivity	Disposal	Spill Clean-Up	Storage Group
zinc acetate	1	1	1	2	21	F_O
zinc carbonate	1	1	1	2	11	D_I/s
zinc chloride	2	1	1	2	11	D_I/s
zinc metal (powder)	1	2	1	2	27a	D_I/s
zinc nitrate	1	2	3	4	12a	B_I
zinc oxide	1	1	1	2	21	D_I/s
zinc stearate	1	1	1	2	21	F_O
zinc sulfate	2	1	1	2	11	D_I/s
zinc sulfide	2	1	1	2	23	D_I/s

In the event that any particular substance is not described, the following references should be consulted to obtain more information:

National Institute for Occupational Health and Safety. 1984. School Science laboratories. A Guide to some Hazardous Substances. Prepared by the Council of State Science Supervisors, U.S. Consumer Product Safety Commission, Washington, D.C. 59 pages.

Armour, M. A., Brown, L. M., and G. L. Weir. 1984. Hazardous Chemicals Information and Disposal Guide (2nd ed.) Department of Chemistry, University of Alberta, Edmonton, Alberta. 287 pages.

Environmental Protection Service, Unpublished Report, Technical Manual for the Management of Chemical Wastes in Laboratories. Industrial Programs Branch, EPS, Environment Canada, Ottawa, Ontario. 325 pages.

Hawley, G. G., 1981. The Condensed Chemical Dictionary (10th ed.) Van Nostrand Reinhold Company, Toronto, Ontario.

Sax, N. I., 1979. Dangerous Properties of Industrial Materials (5th ed.) Van Nostrand Reinhold Company, Toronto, Ontario.

Key to Appendix A

Hazard Ratings

Toxicity and corrosivity
(4) = Extremely dangerous
(3) = Dangerous
(2) = Caution
(1) = Minimal hazard

Flammability
(4) = Extremely dangerous
(3) = Dangerous
(2) = Caution
(1) = Non-flammable

Explosivity
(4) = Extremely dangerous
(3) = Dangerous
(2) = Caution
(1) = Minimal hazard

Disposal Classifications

In addition to the other categories, a column has been placed in the list which indicates 16 preferred types of disposal for the chemical. Chemicals for disposal should be segregated according to the categories listed below and chemicals in categories one and two may be disposed of directly by the user.

Disposal Segregation Categories

1. Chemicals that may be disposed of in small quantities (less than 1 pint or 500 grams at any one time) by dilution with copious quantities of water into a municipal sanitary sewage system. (Please note that a septic tank should not be used.) Check to ensure that local by-laws do not prohibit this practice.

2. Chemicals that are considered to present negligible hazard and may be treated as normal refuse.

Storage Segregation Categories

(Each chemical in categories 3 to 13 is to be kept in its respective container provided the container is intact.

Otherwise, the defective container must be emptied into or packaged in a second container before being segregated for storage.)

3. Non-reactive chemicals.

4. Strong oxidizing agents.

5. Strong reducing agents.

6. Bases (caustic).

7. Acids.

8. Water reactive chemicals which are acid producing.

9. Water reactive chemicals which are base producing.

10. Non-reactive solvents.

11. Halogenated hydrocarbons.

12. Amines.

13. Organic acids and aldehydes.

14. Gas cylinders. (These are to be returned to the manufacturer. If they are refused by the manufacturer, the Provincial Ministry of the Environment should be contacted).

15. PCB's. (Environment Canada should be contacted).

16. Special disposal procedure. (Consult Provincial Ministry for the Environment for instructions).

Spill Cleanup

Category	Personal Protection	Spill Cleanup Actions
1a Organic Acid Halides 1b Inorganic Halides	Rubber gloves, self-contained breathing apparatus or fume hood, lab coat.	Cover with excess sodium bicarbonate. If a small quantity is involved, scoop the mixture into a large beaker of water and let stand for a few minutes. Slowly pour into the drain with copious amounts of water. If a large quantity is involved, scoop the resulting bicarbonate mixture into a plastic bag, cardboard box or small fiber drum. This material can then be burned in an incinerator or spread on the ground and flooded with water. The site of the spill should be washed with soapy water.
2 Aldehydes	Rubber gloves, self-contained breathing apparatus, laboratory coat.	Eliminate all sources of ignition and flammables. **Small** - Absorb on paper towel. Evaporate in fume hood and burn the paper. **Large** - Cover with sodium bisulfite ($NaHSO_3$). Add small amount of water and mix. Scoop into large beaker. After one hour wash down the drain with a large excess of water. Wash site with soap solution.
3 Alkali and Alkaline Earth Metals Metal Alkyls and Alkoxides	Leather gloves, large face shield, laboratory coat. (Class D fire extinguisher should be available)	**Small** - Cover with excess dry soda ash. Mix and add slowly to butyl alcohol. After 24 hours dilute and add to drain with large excess of water. **OR Large Spill** - Mix with dry soda ash. Scoop into a dry bucket. In a remote area spread onto a large iron pan. Cover with scrap wood, paper and ignite with an excelsior train.
4b Organic Halogen and Related Compounds	Rubber gloves, self-contained breathing apparatus, laboratory coat.	Eliminate all sources of ignition. Absorb on paper towels or with vermiculite. Place on an iron, glass or plastic dish in a hood. Allow to evaporate. Burn the paper or vermiculite. Wash site with soap solution.

Spill Cleanup

Category	Personal Protection	Spill Cleanup Actions
4c Substituted Organic Acids	Rubber gloves, self-contained breathing apparatus or all-purpose canister respirator, laboratory coat.	Eliminate all sources of ignition. Turn on the fume hood if acid is volatile. Cover the spill on bench and floor with excess sodium bicarbonate and vermiculite. Mix and scoop into a large beaker of water. When reaction is complete, pour down the drain with a large excess of water. Wash site with soap solution.
5 Aromatic Amines	Butyl rubber gloves, plastic laboratory coat, self-contained breathing apparatus.	**On skin and clothing** - Wash skin with strong soap solution immediately. Rinse thoroughly. Contaminated clothing should be removed, dried, and washed with strong soap solution - or destroyed. It may be necessary to destroy shoes by burning. **Small spills** - Absorb liquids on paper towels. Brush solids onto paper. Place in an iron pan and allow evaporation in the fume hood. Add crumpled paper and burn. Wash site with strong soap solution. **Large spills** - Cover large spills with sand and soda ash mixture (90-10). Mix and shovel into a cardboard box. Pack with much excess crumpled paper. Burn in an open pit or in an incinerator with afterburns and scrubber.
6 Aromatic Halogenated Acids and Nitro Compounds	Butyl rubber gloves, protective laboratory coat, self-contained breathing apparatus, protective shoes.	**On skin** - Wash with strong soap solution **immediately**. Rinse well. **Contaminated gloves, clothing, shoes** - Remove and clean **at once** or destroy by burning.

6	Aromatic Halogenated Acids and Nitro Compounds (continued)		**Small spills** on tables or floor - Absorb liquid spills on paper towels or vermiculite; sweep solid spills onto paper. Put on an iron pan in the fume hood and allow to evaporate. Burn the paper or vermiculite in the absence of other flammables. Wash the site thoroughly with strong soap solution.

Special Note: Certain aromatic nitro compounds, such as picric acid, dinitro's and trinitro's etc.; are explosive and shock sensitive. Contact authorities for further information before dealing with spills involving these compounds.

7	Aliphatic Amines	Butyl rubber gloves, face shield or all-purpose canister respirator, laboratory coat.	**Liquid or solid** - Cover with sodium bisulfate. Spray with water and wash into drain with large excess of water.
8	Azides and Azo Compounds	Leather gloves, heavy face shield, laboratory coat. Work from behind a barricade (body shield or wall). Avoid unnecessary heat, friction or impact.	Absorb the liquid on paper or with vermiculite. If it is a solid, dampen and brush onto paper with great care. Place in plastic bag and take outside for burning. **OR** Sponge up with water, followed by decontamination with a 10% ceric ammonium nitrate solution or 20% sodium nitrite solution.

Special Note: The organic azides and heavy metal azides are explosive. Alkali and alkaline earth azides are not considered explosive under normal laboratory conditions.

Keep stock of all azides very low. Stamp date and receipt on package.

9	Carbon Disulfide	Rubber gloves, safety glasses, laboratory coat. If hood is not available wear self-contained breathing apparatus. Carbon dioxide fire extinguisher should be available.	Eliminate flammables and all sources of ignition. Allow to evaporate or absorb with paper towels and evaporate in hood on an iron pan or glass dish. Burn the paper.

10 Caustic Alkali and Ammonia	Rubber gloves, large face shield (wear all-purpose or special canister respirator for NH_3*), Laboratory coat.	**Solid** - Sweep up, dilute and neutralize with 6M-HCl in a large bucket. Wash down drain with large excess of water. **Solution** - Neutralize and mop up - or use water-vac. Discharge to sewer with large excess of water.
11 Inorganic Salts	Rubber gloves, safety glasses, laboratory coat.	**1. Solutions** - Cover with soda ash, mix and scoop into a beaker of water. Neutralize with 6M-HCl and wash down drain with excess water. **2. Solids** - Collect in a beaker. Dissolve in large amount of water. Add soda ash, mix and treat as above. If spill contains a fluoride, add slaked lime in addition to the above treatment.
12a Oxidizing Agents	Rubber gloves, face shield, laboratory coat. Body shield should be available for the more active agents. Replace face shield with self-contained breathing apparatus for such agents as chlorine and bromine.	**1. Gas leak:** If the valve is leaking because it cannot be closed (a common occurrence), the gas can be bubbled through a reducer (sodium sulfite) and excess sodium bicarbonate solution. Be sure to include a trap in the line to prevent the solution being sucked back into the cylinder. If this cannot be done, the cylinder should be placed in or adjacent to a fume hood and left to bleed off. For fluorine gas do not use a **solution.** Use a scrubber filled with solid bicarbonate, soda lime or granulated charcoal. **2.** If the oxidizer is a liquid or a solid - Cover with a reducer (hypo, a bisulfite, or a ferrous salt but not carbon, sulfur or strong reducing agents). Mix well and spray with water. A sulfite or a ferrous salt will require addition of some 3M-H_2SO_4 to promote rapid reduction. Scoop slurry into a container of water and **neutralize** with soda ash. Wash down the drain with excess water. Wash site thoroughly with a soap solution containing some reducer.

12b Reducing Substances	Rubber gloves, safety glasses, laboratory coat. Work in hood or wear a respirator.	**Gas leak:** Eliminate all sources of ignition. If the valve is leaking because it cannot be closed, the gas can be bubbled through a calcium hypochlorite solution. Be sure to include a trap in the line to prevent the solution being sucked back in the cylinder. **Solid:** Cover spill with soda ash or sodium bicarbonate. Mix and spray with water. If effervescent wait until reaction is complete. Scoop into a large beaker and cautiously add equal volume of calcium hypochlorite (reaction may be vigorous). Add more water, stir, and allow to stand for one hour. Dilute and neutralize the oxidizing solution with 6M-HCl or 6M-NH_4OH as necessary and transfer to the drain with excess of water.
13 Mercaptans and Organic Sulfides	Rubber gloves, self-contained breathing apparatus, laboratory coat.	Eliminate all sources of ignition. Cover with weak aqueous solution of calcium hypochlorite (up to 15%) with stirring. (Sodium hypochlorite available in 5% concentrations as household bleach is also suitable.) Scoop into a large beaker. After 12 hours, neutralize with 6M-HCl or 6M-NH_4OH as necessary. Wash to sewer with excess water. Wash site of spill with strong soap solution to which some hypochlorite has been added. **W A R N I N G !** **Use of dry hypochlorite may cause violent reaction or flash fire.**
14 Cyanides	Long rubber gloves, self-contained breathing apparatus, laboratory apron or coat. Evacuate the laboratory and isolate the area during decontamination.	Scoop into a large beaker and make alkaline with sodium hydroxide solution. Add to the slurry an excess of ferrous sulfate solution. After one hour, flush down the drain with excess water.

15	Ethers	Rubber gloves, large heavy face shield (if in doubt use body shield also). Self-contained breathing apparatus.	Eliminate all sources of ignition and flammables. Adsorb on paper towel. Evaporate from an iron pan in a hood. Allow time for vapors to completely escape the hood vents, then burn the paper. If large spill, absorb on much more paper or vermiculite and allow complete evaporation from all surfaces. Use same precaution before burning paper.
16	Hydrazines	Rubber gloves, self-contained breathing apparatus. Impervious clothing recommended. Body shield should be available.	Eliminate all sources of ignition and flammables. 1. On skin or clothing - Wash skin immediately. Remove contaminated clothing at once. 2. Deluge spill area with large quantities of water and flush the dilute mixture (below 40% hydrazine) to a catch basin for subsequent disposal.
17	Hydrides	Rubber gloves, fire proof clothing, face shield. Work from behind body shield where possible. Keep available pulverized dolomite or dry graphite for fire fighting.	Eliminate all sources of ignition. Scoop in dry plastic bag which has first been purged to inert gas. Remove to the outside for burning. Flood the burned residues with water to ensure complete destruction of hydrides.
18	Hydrocarbons, Alcohols Ketones and Esters	Rubber gloves, face shield, laboratory coat. Have all-purpose canister mask available.	Eliminate all sources of ignition and flammables. 1. A gas leak from a faulty tank - Keep concentration of gas below the explosive mixture range by forced ventilation. Remove tank to an open area and allow dissipation to the atmosphere. Attempt to cap the valve outlet and return tank to the supplier. 2. A liquid - Absorb on paper. Evaporate on an iron pan in a hood. Burn the paper. 3. A solid - Sweep onto paper and place in an iron pan in the hood. Burn the paper and compound.

19 Inorganic Amides and Derivatives	Rubber gloves, large face shield, protective laboratory coat. A large body shield should be available.	Eliminate all sources of ignition. Sweep up solid amide onto dry paper. Cautiously add to cold water in small portions with agitation. Neutralize with 6M-HCl or 6M-NH_4OH as necessary and discharge into drain with large excess of water.
20 Organic Amides	Rubber gloves, safety glasses, laboratory coat.	Scoop into a plastic bag or onto a paper towel. Remove to the outside, add alcohol and burn in a safe place.
21 Miscellaneous Non Hazardous Substances	Rubber gloves, safety glasses, laboratory coat.	**1.** Solutions - Recover with mop and dispose by discarding to sewer. Clean area with soap and water. **2.** Solids - Collect in a beaker or on a tray and dispose as normal refuse. Clean area with soap and water.
22a Inorganic Peroxides	Rubber gloves, large face shield, laboratory coat. A body shield should be available.	Cover with at least double volume of sand-soda ash mixture (90%-10%). Mix thoroughly and break up any lumps of peroxide. With a plastic scoop add slowly to a large beaker of sodium sulfite solution (3 or 4 litres) with stirring. Neutralize with dilute sulfuric acid. When settled decant the sulfate solution into drain with excess water. The sand can be sent to the landfill. **Hydrogen Peroxide** (spill or package lots): Dilute and wash down drain with excess of water.
22b Organic Peroxides	Rubber gloves, large heavy face shield, laboratory coat. Work from behind heavy body shield in hood.	Eliminate all sources of ignition. **1. Liquid** peroxide spills may be absorbed in large quantity of vermiculite or sand. Using a soft plastic scoop, carefully place the mixture in a plastic container. Spread on a steel pan or in a deep pit. Ignite from a distance with an excelsior train or a long torch. Wash the scoop and container with 30% $FeSO_4$-H_2O. Burn the original cartons and bags.

22b Organic Peroxides (continued)		2. **Solid** peroxide spills should be mixed with a large volume of vermiculite or sand. Carefully transfer as above and burn. 3. A very small quantity of #1 or #2 may be destroyed by adding 10 volumes of 20% NaOH. After 24 hours, neutralize with 6M-HCl and pass into drain with large excess of water.

CAUTION: Keep stock low and date each container as received. Never transfer to glass stoppered containers or screw cap bottles which can cause dangerous friction.

23 Inorganic Sulfides	Rubber gloves, safety glasses. Work in hood or wear self-contained breathing apparatus, laboratory coat.	Eliminate all sources of ignition. Add $FeCl_3$ solution. Stir until FeS formation is complete. Add slight excess of soda ash. Scoop up and wash into drain with excess water. Wash site with soap solution. **OR** Absorb with vermiculite or sodium bicarbonate and scoop into plastic bag or wide-mouthed glass jar. Close tightly, remove to safe place outside and add $FeCl_3$ solution. Stir until reaction is complete. Add slight excess sodium bicarbonate and wash into drain with excess water.
24a Organic Acids	Rubber gloves, face shield, laboratory coat. Body shield and self-contained breathing apparatus should be available.	Eliminate all sources of ignition. 1. Cover contaminated surfaces with soda ash or sodium bicarbonate. Mix and add water if necessary. Scoop up slurry and wash neutral (6M-NH_4OH or 6M-HCl as required) waste down drain with excess water. Wash site with soda ash solution.
24b Inorganic Acids	Rubber gloves, self contained breathing apparatus, laboratory coat. Have body shield available.	1. Cover the contaminated surface with sodium bicarbonate or a soda ash - slaked lime mixture (50-50). Mix and add water if necessary to form a slurry. Scoop up slurry and wash down the drain with excess water. Wash site with soda ash solution.

25 Carbides	Rubber gloves, safety glasses, laboratory coat.	Cover with dry vermiculite, scoop into a dry bucket or plastic bag and transfer to a safe open area. Dispose of the material cautiously by adding it slowly to a large volume of water. Burn the hydrocarbon gas using a pilot burner. Allow to stand for 24 hours and run to sewer with excess water.
27a Scrap Metals	Heavy gloves, safety glasses, laboratory coat.	Recover and consign for salvage. Small quantities may be assigned to landfill.
27b Mercury	Rubber gloves, self-contained breathing apparatus, laboratory coat.	**Metal** - Collect all droplets and pools at once by means of suction pump and aspirator bottle with a long capillary tube. Cover fine droplets in non-accessible cracks with calcium polysulfide and excess sulfur. Combine all contaminated mercury in a tightly stoppered bottle. Retain remnants and contact environmental authorities for advice regarding final disposal. **CAUTION:** The toxicity of mercury is such that the element and its compounds should not be allowed to contaminate air or water.
27c Phosphorus	Rubber gloves, large face shield.	White or yellow phosphorous. Cover with wet sand. Spray with water to keep sand wet. Scoop into a bucket of water. After standing overnight, recover and repackage. OR If quantity is very small (e.g., fragments of sticks of yellow phosphorus), cover with water and remove to an open area. Pour onto the ground or a steel pan. The water will evaporate and dry yellow phosphorous will ignite spontaneously in air and burn away. Red Phosphorus. Sweep up and burn on an iron pan in the hood.

27d Arsenic, Antimony and Bismuth	Rubber gloves, safety glasses, respirator, laboratory coat. Work in fume hood.	Recover solids by carefully sweeping up with small scoop. Recover liquids by absorbing with vermiculite. Retain remnants and consult environmental authorities for advice regarding final disposal.
27f Lead, Cadmium and Chromium	Rubber gloves, safety glasses, respirator or work in fume hood.	Recover solids by carefully sweeping up with a small scoop. Recover solutions by absorbing with vermiculite. Exercise extreme caution with nitrates. Retain remnants and consult environmental authorities for advice regarding final disposal.
27h Strontium and Barium Compounds	Rubber gloves, safety glasses and laboratory coat.	Recover solids by carefully sweeping up with a small scoop. Recover solutions by absorbing with vermiculite. Exercise caution with nitrates and do not contaminate with organic materials. Retain remnants and consult environmental authorities for advice regarding final disposal.
27i Vanadium Compounds	Rubber gloves, large face shield, laboratory coat. (Wear self-contained respirator if spill is large.)	Cover with powdered ammonium carbonate. Add a layer of crushed ice and spray with 6M-NH_4OH while stirring. Scoop slurry into a wide mouth bottle, save for salvage. Wash site with soap water.

Special Note: Disposal procedures for remnants of spills are not applicable to bulk chemicals. Consult the disposal column and pertinent explanations for disposal of bulk chemicals.

28 Collodion (Nitrocellulose Lacquer)	Rubber gloves, face shield and work outside or in fume hood.	Eliminate sources of ignition. Absorb spilled material with paper towels or rags. Remove to an outside open area, spread on the ground and ignite with an excelsior train or a long torch. Avoid direct breathing of vapours.

Storage Category

In this storage system inorganic compounds are classified into the following compatible groups.

Class A_I

This category contains inorganic acids, excluding all inorganic acids capable of behaving as oxidizing agents (e.g., nitric acid (HNO_3), perchloric acid ($HClO_4$) and nitrous acid (HNO_2)) as well as cyanic acid. The common inorganic acids included in this section are: boric acid (H_3BO_3), carbonic acid (H_2CO_3), phosphoric acid (H_3PO_4), hydrochloric acid (HCL), hydrogen sulfide (H_2SO_3), sulfuric acid (H_2SO_4), hydrobromic acid (HBr), and hydroiodic acid (HI).

Notes:

1. Nitric and nitrous acid should be further separated from the above binary and oxy acids.
2. Although a 70% perchloric acid/water mixture is not explosive by itself, the use of perchloric acid often leads to the formation of solid perchlorates which are very explosive. It is recommended this be removed from school laboratories.
3. Due to its toxic and explosive risks cyanic acid should be removed from school laboratories.

Class B_I

Inorganic salts capable of acting as oxidizing agents. Included in this section are inorganic nitrate/nitrite salts*, all inorganic oxidizers

* Further isolate ammonium nitrate/nitrite salts.

such as metal peroxides and potassium permanganate, concentrated halogen solutions, chlorates,chlorites, perchlorates and hypochlorites.

Class C_I

Chemicals contained in this group are all air/or water sensitive chemicals including all alkali and alkaline metals, hydrides, carbides, aluminum chloride, phosphorous chloride, phosphorous pentoxide and elemental phosphorous. It is recommended elemental phosphorous be further separated from the alkali metals.

Class D_I

This section contains (except cyanides) all remaining inorganic salts, reducing agents, inorganic bases in both the solid and liquid state, elemental amalgam compounds and all non-water/air sensitive elements.* It is suggested, depending on storage space, that the inorganic bases be further separate from the remaining class D_I compounds.

The organic chemicals are also further subdivided according to the following classifications.

Class EO

This classification covers all organic bases in both the solid and liquid state including amines, amides, alkoxides, aniline, carboxylate salts and/or solutions. It is further suggested, that with available storage space solids be separated from liquids.

* If carbon disulfide is necessary it should be placed in this category but kept cool and well sealed due to its low flashpoint (-30°C) and neurological toxin properties.

Class F_O

This category covers all organic solid compounds excluding organic acids, bases, oxidizers and cyanides. Included in this classification are metal acetates, solid polyhydroxy aldehydes and ketones, solid esters, solid halogenated aliphatic, olefinic and aromatic compounds, solid organometallics*, high molecular weight alkanes, alkenes and alkynes, and solid aliphatic, olefinic and aromatic alcohols.

Class G_O

Included in this category are all organic solvents and organic acids with the exception of cyanides. This covers all liquid alkanes, alkenes and aromatic hydrocarbons, liquid aliphatic, olefinic and aromatic alcohols, all liquid halogenated hydrocarbons and all organic acids liquid or solid.

Class H_O

Included in this classification are all organic oxidizers. This section contains benzoyl peroxide which can explode spontaneously when dry. It is recommended that benzoyl peroxide be removed from the school laboratory if present.

Class I

This category includes all gas cylinders.

The following two classes contain cyanide/cyanate chemicals of organic and inorganic nature.

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* It is recommended that any organometallic chemicals be removed from school laboratories because of their inherent reactivity.

Class J

This classification includes all organic and inorganic cyanide containing chemicals.

Class K

Included in this category are organic and inorganic isocyanates.

Appendix B

Special Chemical Hazard Information

Several chemicals listed in Appendix A present an extreme hazard by virtue of their corrosive, toxic, flammable or explosive characteristics. The use or storage of these compounds in schools is not recommended because their potential usefulness is outweighed by their associated risks even when handled with caution. The following is a description of the characteristics of the most commonly encountered extremely hazardous chemicals.

Acetyl Chloride (ethanoyl chloride) CH_3COCl

Acetyl chloride is a colourless, fuming liquid with a strong odour. It is corrosive to skin and mucous membranes, as well as being toxic and a strong irritant to the eyes. Is a dangerous fire risk with a flash point of 4°C. When heated to decomposition, hydrogen chloride and phosgene, extremely poisonous gases, are evolved. Acetyl chloride reacts violently with water to form acetic and hydrochlorine acids.

Aniline (Aniline oil, phenylamine, amino benzene) $C_6H_5NH_2$

Aniline is a colourless oily liquid, the vapours of which form explosive mixtures with air. Aniline is highly toxic when absorbed through the skin, inhaled as a vapour, or swallowed. Excessive exposures can cause respiratory paralysis.

Bromine (reagent) Br

Bromine is a dark reddish-brown fuming liquid. It is corrosive to skin or tissue upon contact. As a vapour or gas it is very irritating to eyes and lungs and can cause respiratory tract damage at concentrations of 10 parts per million. It is non-flammable but may ignite combustible materials on contact. Bromine is also reactive with some metals and other compounds.

Carbon Disulfide (Carbon Bisulfide) CS_2

Carbon Disulfide is a clear, colourless to slightly yellow liquid. It is almost odourless when pure, otherwise, it exhibits a strong disagreeable odour. The liquid is poisonous with a tolerance of 10 parts per million in air. It is a dangerous fire and explosion risk since it gives off flammable vapours at low temperatures. The explosive limits in air range from 1 to 50% with a flash point of -30°C. The heat from an ordinary light bulb is sufficient to ignite the vapours.

Carbon Tetrachloride (tetrachloromethane, perchloromethane) CCl_4

Carbon tetrachloride is a colourless liquid with a sweetish distinctive odour. It is toxic by ingestion, inhalation and skin absorbtion. It is a narcotic and has a tolerance of 5 ppm in air. Carbon tetrachloride is a known carcinogen. It decomposes to phosgene gas at high temperatures.

2,4-Dinitrophenylhydrazine $(NO_2)_2C_6H_3NHNH_2$

Dinitrophenylhydrazine is a red crystalline powder. The primary hazards associated with this chemical are it severe explosive and fire risk. It is used in the manufacture of explosives.

Hydrofluoric Acid (Hydrogen Fluoride) HF

Hydrofluoric Acid is a colourless, fuming, and mobile liquid. It is the strongest acid known. Contact with the skin causes very serious burns which are difficult to neutralize and treat medically. Contact with the eyes can cause immediate blindness. It is highly irritating and damaging to the respiratory tract. Hydrofluoric Acid corrodes most substances including glass.

High Energy Oxidizers - Peroxides and Peroxide Forming Compounds

This section includes a description of the characteristics of Benzoyl Peroxide, Diethyl Ether, Lauroyl Peroxide, Perchloric Acid and other high energy oxidizers.

High energy oxidizing materials includes any compound that spontaneously evolves oxygen either at room temperature or under slight heating. These compounds can also react vigorously at room temperature when stored near or in contact with reducing materials and other organic compounds. The term oxidizing material includes such chemicals as peroxides, chlorates, perchlorates, nitrates and permanganates.

Benzoyl Peroxide (Dibenzoyl Peroxide) - $(C_6H_5CO)_2O_2$

Benzoyl Peroxide is a white granular powder or crystalline solid. In the dry state, benzoyl peroxide is highly flammable and at elevated temperatures becomes unstable and spontaneously explosive. It is an oxidizing agent and strong supporter of combustion. It is extremely sensitive to shock, heat and friction.

Diethyl Ether and Similar Compoun

Diethyl Ether is a colorless, volatile, mobile liquid with a aromatic odour. It is a central nervous system depressant by inhalation and skin absorbtion. Diethyl ether itself is extremely flammable and is a severe fire and explosion hazard when exposed to heat or flame. The formation of peroxides also result in a severe explosion hazard.

Formation of Peroxides

The rate of formation of peroxides in ethers varies with the type of container, and conditions of exposure. Auto-oxidation resulting from exposure to air, as in opened or partially filled containers, accelerates formation of peroxides in ethers (Rosin, 1961) (Noller, 1951). Exposure to light may play a role in the formation of peroxides in ethers. Peroxides formed in ethyl ether, isopropyl ether, dioxane, tetrahydrofuran and many other ethers have caused unexpected explosions even from residues found in "empty" 250 ml containers (CRC, 1976).

Detection of Peroxides

If appreciable quantities of crystalline solids are observed in solution or surrounding a cap or if viscous liquids are observed in ether vessels, this should be considered as gross evidence of the formation of peroxides. If this is noted no further handling is recommended and the proper authorities should be contacted. Peroxides are shock and heat sensitive so detonation can occur by merely unscrewing the cap! It should be noted that isopropyl ether is unusually susceptible to autoxidation so that even opening a container of isopropyl ether with normal appearance, but uncertain vintage, may be hazardous. It is recommended that ethers not be used in high school laboratories.

Lauroyl Peroxide (Dodecanoyl Peroxide) - $(C_{11}H_{23}CO)O_2$

Lauroyl Peroxide is a white course powder. In a dry state, lauroyl peroxide is combustible and at elevated temperatures it decomposes and may become explosive above 49°C self accelerating decomposition occurs. It is shock sensitive when heated. Spontaneous chemical reaction, ignition or explosion may occur if lauroyl peroxide is mixed with readily oxidizable, organic or flammable materials.

Perchloric Acid $HClO_4$

Perchloric Acid is a colourless, fuming, oily odourless liquid. It is a strong skin and eye irritant and is highly toxic by inhalation and ingestion. Perchloric acid at 70% acid/30% water has negligible oxidizing power, but at elevated temperatures (small lab fire) or under anhydrous conditions (dry/time expired) it is an exceedingly strong oxidizing agent. Many serious laboratory accidents which have been reported involved less than one gram of perchloric acid. If, in the event of an emergency, perchloric acid and acetic acid be allowed to mix, they would instantaneously explode generating hydrochloride vapors whose temperature would be 2400°C. Burton and Praill; (1955) reported that one gram of perchloric acid instantly generates, under these conditions, seven litres of hydrochloride gas.

Phosphorus (Yellow Phosphorus, White Phosphorus) P

The most common air sensitive chemical found in laboratories is elemental phosphorus. White (or yellow) phosphorus will at 30°C, ignite spontaneously with air and should, for this reason, be stored under a layer of water. If phosphorous is required, it is recommended that red phosphorous be used since it is less air sensitive and not a fire hazard under normal conditions. Red phosphorous should also be stored under water and away from alkaline metals, since they could react generating toxic phosphine gas.

Picric Acid (Trinitrophenol; picronitric acid; nitroxanthic acid; carbazotic acid; phenoltrinitrate) $C_6H_2(NO_2)_3OH$

Picric acid is a yellow crystalline substance. It is toxic by skin absorbtion and the tolerance for it in air is 0.1 mg/m^3. Picric acid is explosive when dry (i.e.: less than 10% water content). The acid is generally stored under water. Containers where crystallization is apparent should not be opened and must be treated with extreme caution. Shocks, heat or friction can detonate picric acid if it is in a dry crystalline form. It also forms highly sensitive explosive compounds with metals, especially copper, lead, zinc, or ammonium salts. Upon discovery of picric acid in the school laboratory prompt notification of Environmental or police authorities is recommended.

Sodium and Potassium (including other Alkali Metals and Alkaline Earth Metals)

The most hazardous property of the alkali metals are their flammability and their violent reaction with water. Alkali metals in combination with water react to generate heat and hydrogen gas. If the heat of the reaction is sufficient, explosive ignition of the hydrogen gas will occur.

Sodium and Potassium (including other Alkali Metals and Alkaline Earth Metals) - (continued)

Sodium, potassium and rubidium react violently in this manner while lithium reacts slowly with water at room temperature, but explosively at higher temperatures.

Under certain conditions some of the metals may ignite spontaneously upon exposure to air. Potassium metal not stored under kerosene should be treated with great caution since explosive peroxides may have formed. In order to prevent ignition via formation of peroxides or water contact all alkali metals should be stored under kerosene or a similar high molecular weight hydrocarbon.

Although the alkaline earth metals are less reactive than the alkali metals, calcium and strontium react with water to liberate hydrogen as will magnesium in slightly acidic aqueous solutions. Beryllium is a known carcinogen and its removal from the laboratory is recommended. Because the alkaline metals are not extremely water sensitive, they can be stored in well sealed containers, but their quantity should be limited.

Other Water Sensitive Chemicals (Phosphorus pentoxide, Phosphorus trichloride, Lithium aluminum hydride and others)

Other water sensitive chemicals that may be encountered are hydrides and carbides. If these chemicals are required they should be stored in a well sealed container and placed in a desiccator containing indicating silica gel. Phosphorous pentoxide and phosphorous trichloride also react violently with water and these should be stored in tightly sealed containers with further removal from any potential source of water.

Lithium aluminum hydride is also sensitive to atmospheric moisture and friction and also reacts violently with many organic materials. It is a strong reducer and is highly caustic on inhalation, ingestion or contact with the skin.